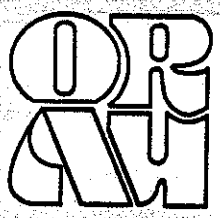
ORAU 91/L-36



Prepared by
Oak Ridge Associated Universities

Prepared for the
Office of
Environmental
Restoration

U.S. Department
of Energy

RADIOLOGICAL SURVEY OF THE BAKER AND WILLIAMS WAREHOUSES BUILDING 513-519 NEW YORK, NEW YORK

P. R. COTTEN AND J. L. PAYNE

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

FINAL REPORT
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Office of Environmental Restoration

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RADIOLOGICAL SURVEY
OF THE
BAKER AND WILLIAMS WAREHOUSES
BUILDING 513-519
NEW YORK, NEW YORK

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RADIOLOGICAL SURVEY
OF THE
BAKER AND WILLIAMS WAREHOUSES
BUILDING 513-519
NEW YORK, NEW YORK

INTRODUCTION AND SITE HISTORY

During the early 1940's, the Manhattan Engineer District (MED), predecessor agency to the Atomic Energy Commission (AEC) and the Department of Energy (DOE), shipped uranium concentrates to the former Baker and Williams Warehouses on West 20th Street, in New York, New York. The warehouses were used for short term storage of the uranium that was later distributed to U.S. Government Facilities. According to historical information, approximately 99, 430 kg (219,000 lbs) of orange and yellow sodium uranate were delivered in 1942 and approximately 39,000 kg (86,000 lbs) of orange and yellow sodium uranate, 10,000 kg (22,000 lbs) of sodium uranyl carbonate, and 9,080 kg (20,000 lbs) of black uranium oxide were delivered to BWW in 1943. Since the 1940's, the warehouses have been leased by several businesses and are currently owned by Ralph Ferrara, Inc.

The Baker and Williams Company owned three adjacent warehouse buildings at 513-519, 521-527, and 529-535 West 20th Street during the 1940's. Historical shipping documents indicate that MED/AEC shipments of uranium concentrates were delivered to the shipping and receiving office located at Building 529-535; however, shipments may have been received, unloaded and/or stored at either of the adjacent warehouse buildings. Adjoining doorways between building 521-527 and 529-535 allowed convenient access between the two buildings.

In 1989, DOE's Office of Environmental Restoration reviewed available historical documentation that described the previous MED/AEC activities conducted at this facility, and based on this information, determined that the potential for radioactive material to be present as

a result of the past activities was low. However, the information was insufficient to verify the radiological condition of the site after MED/AEC activities were terminated. DOE decided that a radiological survey should be performed to determine whether additional investigations were warranted under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The purpose of the radiological survey is to obtain sufficient radiological measurements to make a recommendation to DOE Headquarters as to whether a site should be included for remedial action or eliminated from FUSRAP.[1] DOE obtained consent from the owners to enter the property at 529-535. A preliminary site visit was performed by representatives of the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Associated Universities (ORAU), and it was determined that Building 521-527 would be included in the survey, based on a visual inspection and accessibility into the adjoining 529-535 building. Consent to enter the property at 513-519 had not been obtained at that time.

In August 1989, ESSAP conducted a radiological survey of the interior surfaces of Buildings 521-527 and 529-535.[2] Areas of elevated direct radiation, in excess of DOE guidelines for residual activity, were detected in Building 521-527 on the floor in the West Bay of the ground level and in several small areas on the floor and lower walls in the East Bay of the basement. No contamination was detected on the remaining levels in 521-527 or in Building 529-535. As a result of the findings by ESSAP, the Baker and Williams Warehouses were designated by DOE to be addressed under the proposed expedited protocol for remedial actions at small FUSRAP sites. Under the expedited protocol, the contractor which performs the radiological activities also performs the characterization and verification for the project. At the time characterization activities were scheduled for Building 521-527 DOE had obtained consent to enter the property at 513-519. Therefore, DOE requested ESSAP to conduct a radiological survey as a continuation of the phase of Building 513-519 in conjunction with the radiological characterization of Building 521-527. This report describes the radiological survey of Building 513-519 of the Baker and Williams Warehouses.

PROJECT ORGANIZATION AND RESPONSIBILITY

DOE Headquarters provides overview and coordination for all FUSRAP activities. DOE Oak Ridge (DOE-OR) is responsible for implementation of FUSRAP and the Former Sites Restoration Division of DOE-OR, manages the daily activities.

Under the FUSRAP protocol an initial investigation or, of a potential site is performed by ORAU or Oak Ridge National Laboratory (ORNL) under contract to DOE Headquarters. If appropriate, DOE Headquarters designates the site into FUSRAP based upon the results provided by the initial investigation. DOE's Project Management Contractor (PMC) for FUSRAP is Bechtel National, Inc. (BNI). BNI is responsible for planning and implementation of FUSRAP activities and managing the site characterization and remedial actions. The final phase for a FUSRAP site is independent verification which is provided by ORAU or ORNL after remedial action is complete. The verification survey confirms that remedial actions at the site have been effective in meeting current guidelines and assures that documentation accurately and adequately describes the post-remedial action radiological condition of the site. DOE Headquarters uses the information developed by the remedial and verification activities to certify that a site can be released for unrestricted use.

The Baker and Williams Warehouses were selected for remediation under a proposed expedited protocol being considered within FUSRAP. In contrast to the standard protocol, under the proposed expedited protocol, the contractor for this site, ORAU, functions as the organization responsible for the characterization and verification activities, while BNI is responsible for conducting the remedial action and post-remedial action surveys.

FACILITY DESCRIPTION

The Baker and Williams Warehouses are located on the west side of Central New York City, in the borough of Manhattan (Figure 1). Building 513-519 has approximately 775 m^2 (8340 ft^2) per floor of storage space; there are a total of 8 levels. Figure 2 illustrates the general

floor plan throughout the Building, although some levels have slight modifications to meet the specific needs of the owners. Fireproof materials such as steel, concrete, and brick were used in the construction of the building. The floors are concrete and a layer of asphalt has been applied on all levels. The interior walls are constructed of masonry brick. Due to the quantity of items and material stored on each level, accessibility to the floor and wall surfaces was limited to less than 50% of the total area.

PROCEDURES

Objective

The objective of the survey was to determine the radiological status of the property, relative to the FUSRAP guidelines and the DOE Order 5400.5, Chapter IV. The results will be used by DOE to determine whether there is a need for remedial actions in Building 513-519. During the periods between March 11-22, 1991 and April 22-30, 1991, ESSAP performed a radiological survey of Buildings 513-519.

Surface Scans

Surface scans to identify evidence of residual radioactivity were performed on each level on all accessible floor and lower wall surfaces. Gamma scans were performed using NaI(Tl) scintillation detectors. A large-area gas-proportional detector was used to perform alpha-plus-beta scans of the floor. Walls, ledges, and overhead piping were scanned using ZnS scintillation detectors or GM "pancake" detectors. All detectors were coupled to countrate meters with audible signal outputs.

Measurement of Surface Activity Levels

The radionuclide of concern is processed natural uranium, i.e. uranium chemically separated from its daughter products, but in its naturally occurring isotopic abundances.

Processed natural uranium emits both alpha and beta radiation in approximately equal proportions, either beta activity levels or alpha activity levels may, therefore, be measured for determining uranium surface contamination.

Measurements for total and removable alpha and beta-gamma activity were performed at randomly selected locations and at locations of elevated activity, identified from the surface scans. A smear sample for determining removable activity was obtained at each measurement location. A total of 236 measurements were performed. Measurement locations were referenced to prominent building features and recorded onto the survey drawings (Figures 3-10).

Exposure Rate Measurements

Background exposure rate measurements were performed at 1 meter (3.3 ft) above the surface at 4 representative building locations of similar construction and without a history of radioactive materials use.

Exposure rate measurements in Building 513-519 were performed at 1 meter (3.3 ft) above the floor surface on each level. A NaI(Tl) gamma scintillation detector, cross calibrated on-site with a pressurized ionization chamber (PIC), was used to obtain these measurements.

Miscellaneous Samples

A sample of the asphalt floor covering was collected from an area of elevated activity in the East Bay of the basement.

Sample Analysis and Interpretation

All samples and data were returned to the ESSAP laboratory at ORAU for analysis and interpretation. Smears were analyzed for gross alpha and gross beta activity and the sample of asphalt floor covering was analyzed using gamma spectrometry. Surface activity measurements

were converted to units of disintegrations per minute per 100 cm^2. The activity in the asphalt sample is reported in units of pCi/g. Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Findings were compared to the DOE guidelines for release for unrestricted use which are provided in Appendix C.

FINDINGS AND RESULTS

Surface Scans

Gamma and alpha-plus-beta scans in Building 513-519, identified elevated levels of residual activity in both bays of the basement and in the East Bay on levels one, three, and five (Figures 3, 4, 6, and 8). Elevated activity was limited to small areas on all levels, with the exception of the third level where significant elevated activity was identified over approximately 90% of the accessible floor area and on horizontal surfaces such as ledges and overhead piping.

Measurement of Surface Activity Levels

Measurement results for total and removable alpha and beta-gamma activity are summarized in Table 1. Total activity levels ranged from <70 to 9,100 dpm/100 cm^2 for alpha and ranged from <930 to 710,000 dpm/100 cm^2 for beta-gamma, with the highest levels located on the floor of the third level, East Bay. Removable activity levels ranged from <6 to 340 dpm/100 cm^2 for alpha and from <13 to 320 dpm/100 cm^2 for beta, with the highest levels also located on the floor of the third level.

Exposure Rate Measurements

Background exposure rate measurements ranged from 10 to 14 μR/h. Exposure rate levels in Building 513-519 ranged from 10 to 14 μR/h and did not vary from background.

Radionuclide Concentration in Miscellaneous Sample

A sample of the asphalt floor covering was collected from the East Bay of the basement from an area of elevated activity confirm the contaminant. Analysis of the sample identified uranium as the primary contaminant. Radionuclide concentrations for U-235 and U-238 are 26 $\pm$ 2 pCi/g, and 450 $\pm$ 4 pCi/g, respectively; these are the naturally occurring ratios of these two isotopes. No additional gamma emitting radionuclides of naturally occurring isotopes, other than background levels, were noted.

COMPARISON OF RESULTS WITH GUIDELINES

The DOE guidelines for residual radioactive material are included as Appendix C. The DOE surface activity guideline levels applicable for processed natural uranium are as follows:

Total Activity

5,000 dpm α/100 cm^2, averaged over a 1 m^2 area

15,000 dpm α/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1,000 dpm α/100 cm^2

Previous survey results indicate that measurements for beta activity levels, rather than alpha activity, provide a more accurate representation of uranium activity levels on dusty, porous, or rough surfaces, which may selectively attenuate the alpha activity. Therefore, beta activity levels were used for comparison with the guideline values. Areas were identified on the basement, first, and third levels in Building 513-519 which exceed the surface guidelines for total residual activity. Total activity between the average and maximum guideline levels was measured on the fifth level, and further evaluation of this level is necessary, based on these results. The highest measurements for total activity were identified on the basement level and the third level.

Exposure rate measurements were within the guideline of 20 μR/h above background guideline.

SUMMARY

In March and April, 1991, ORAU performed a radiological survey of the facility located at 513-519 West 20th Street, New York, New York. Survey activities included alpha, beta, and gamma scans, measurements for total and removable activity and exposure rates, and sample analysis. All levels in the building are currently used for storage, thereby limiting the access to the entire surface area.

Residual contamination exceeding DOE guideline levels was detected on the floor in both bays of the basement, and on the East Bay floors of the first and third levels. The horizontal surfaces in the East Bay of the third level were also identified as having elevated activity. Areas of elevated residual activity were also identified in the East Bay of the fifth level. Because of the limited accessibility of floor and wall surfaces to detection equipment, additional locations of contamination are likely to be present. Surface contamination appears to be fixed; removable contamination levels and external radiation levels (gamma exposure rates) are within the DOE guidelines. Based upon the survey results, it is ORAU's opinion that there is not currently a significant risk to workers or members of the public from residual contamination at this site under present conditions of facility use.

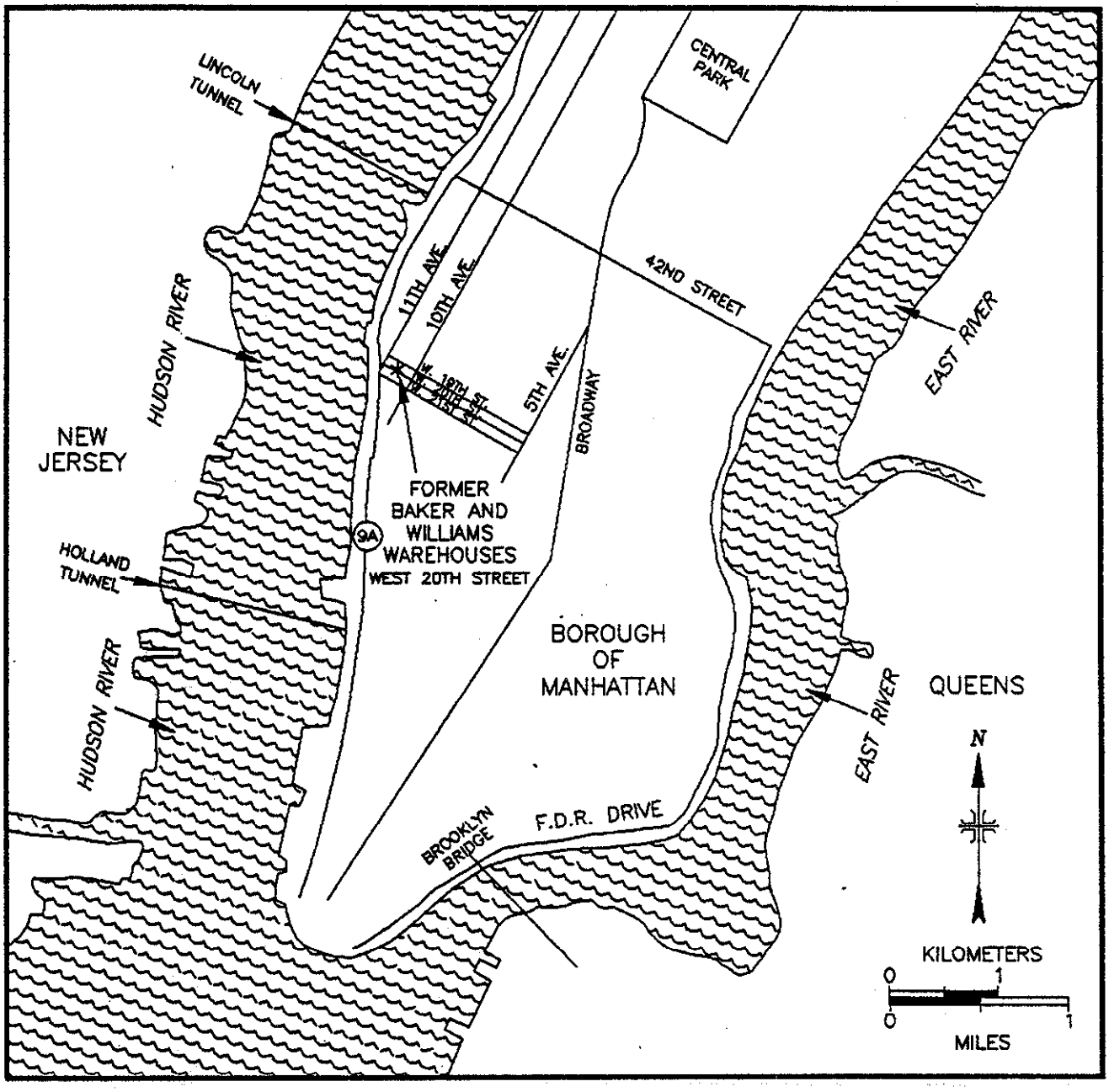

FIGURE 1: Location of the Baker and Williams Warehouses

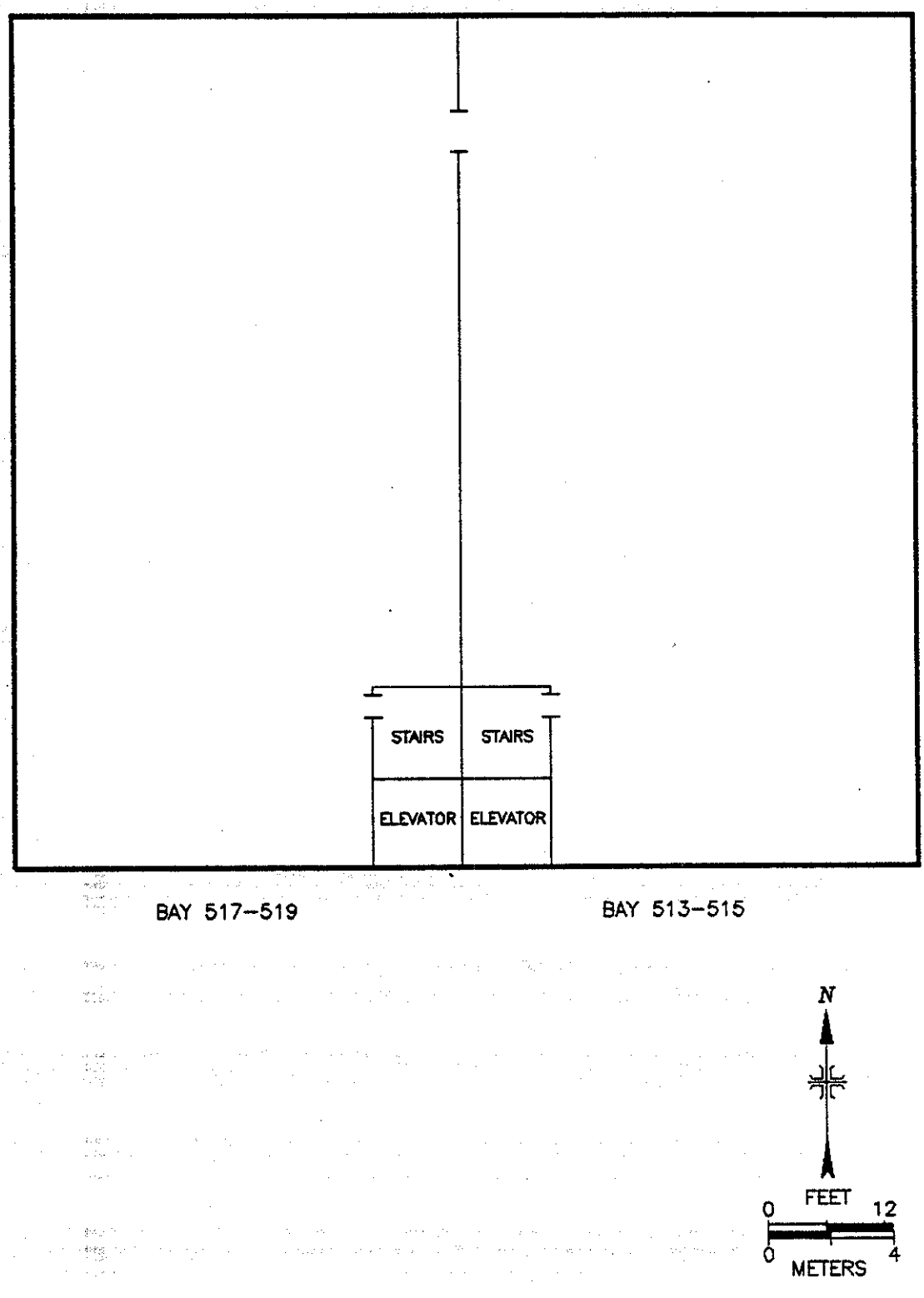

FIGURE 2: Floor Plan of Building 513–519

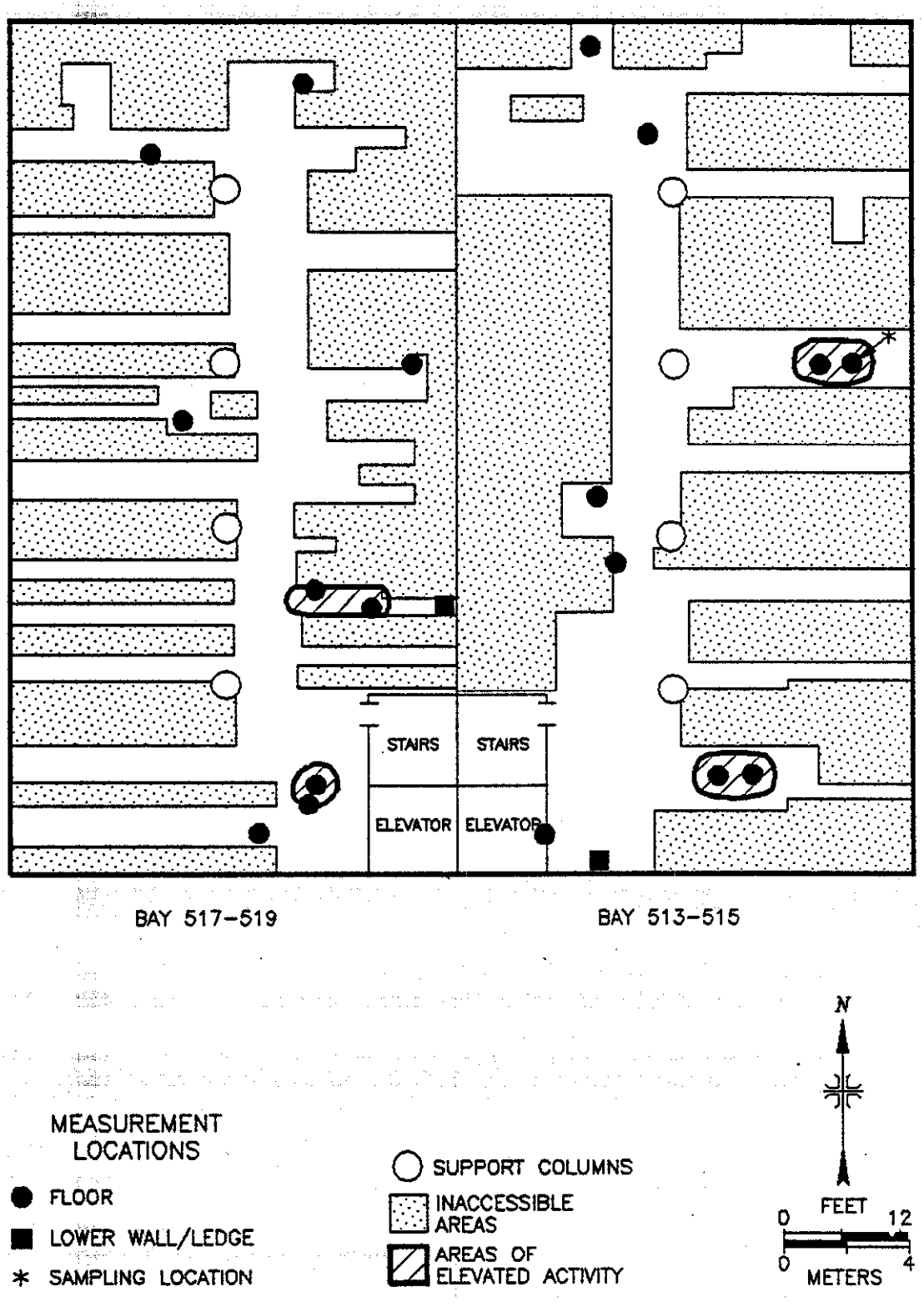

FIGURE 3: Basement – Measurement Locations

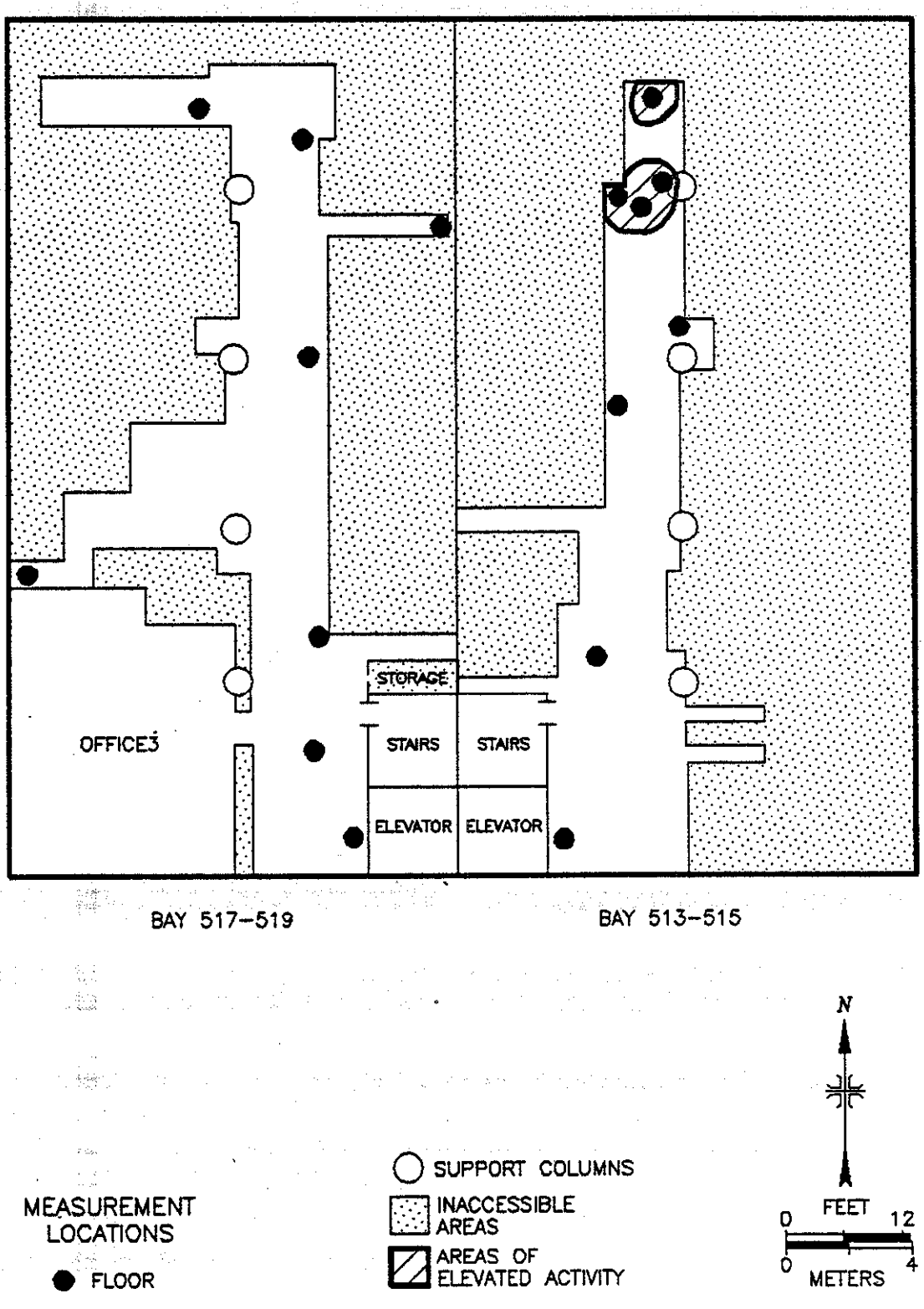

FIGURE 4: First Level – Measurement Locations

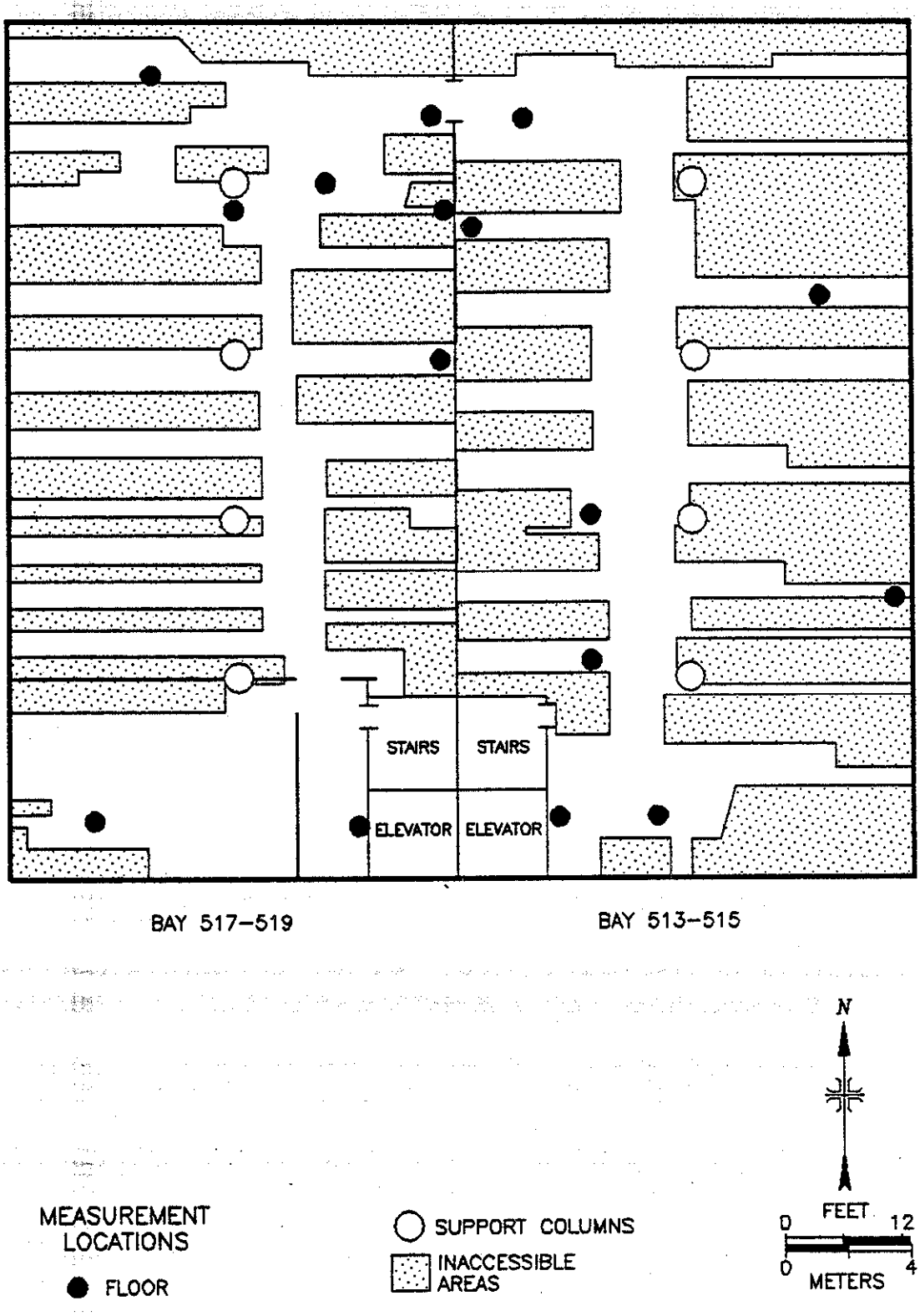

FIGURE 5: Second Level – Measurement Locations

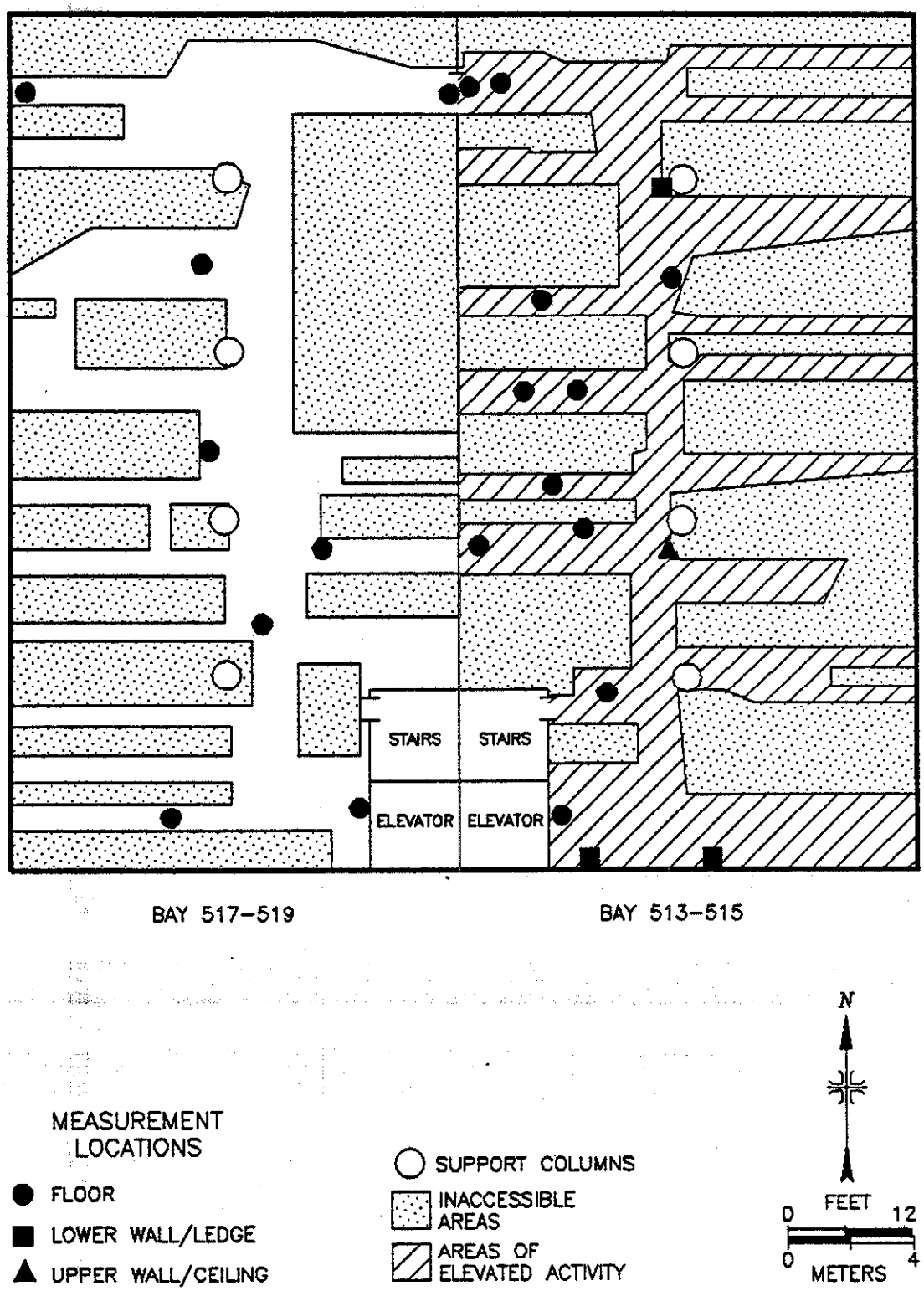

FIGURE 6: Third Level – Measurement Locations

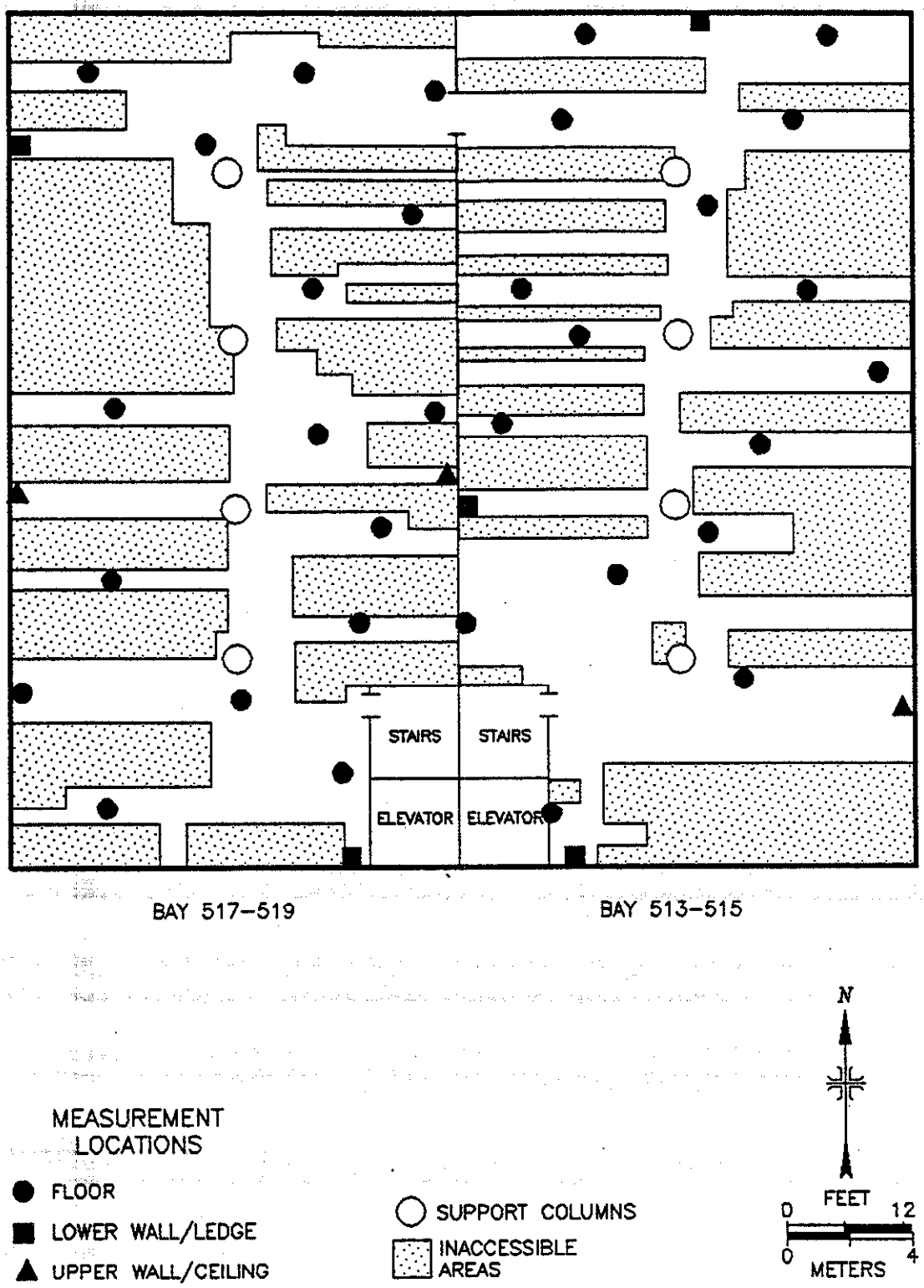

FIGURE 7: Fourth Level – Measurement Locations

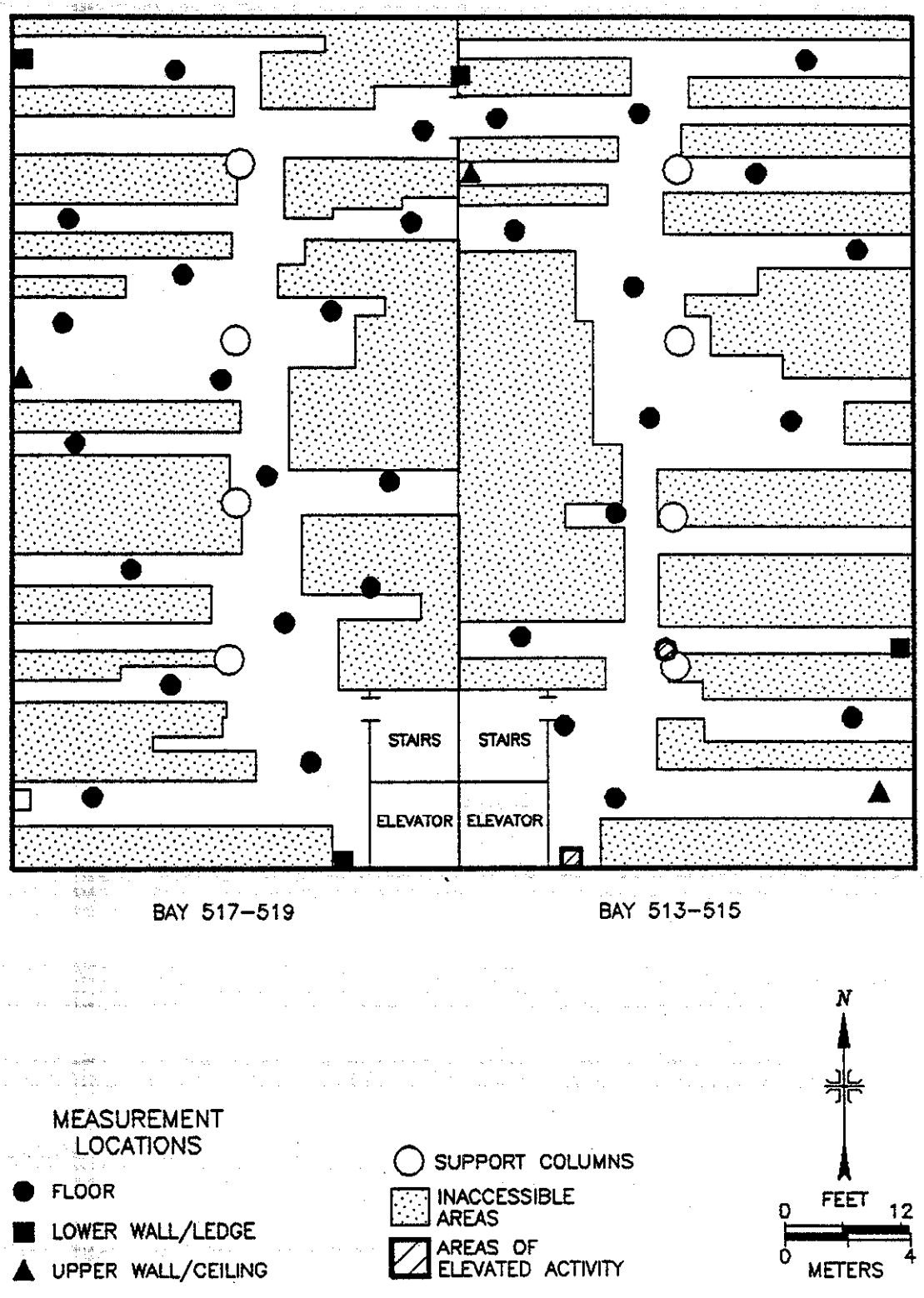

FIGURE 8: Fifth Level – Measurement Locations

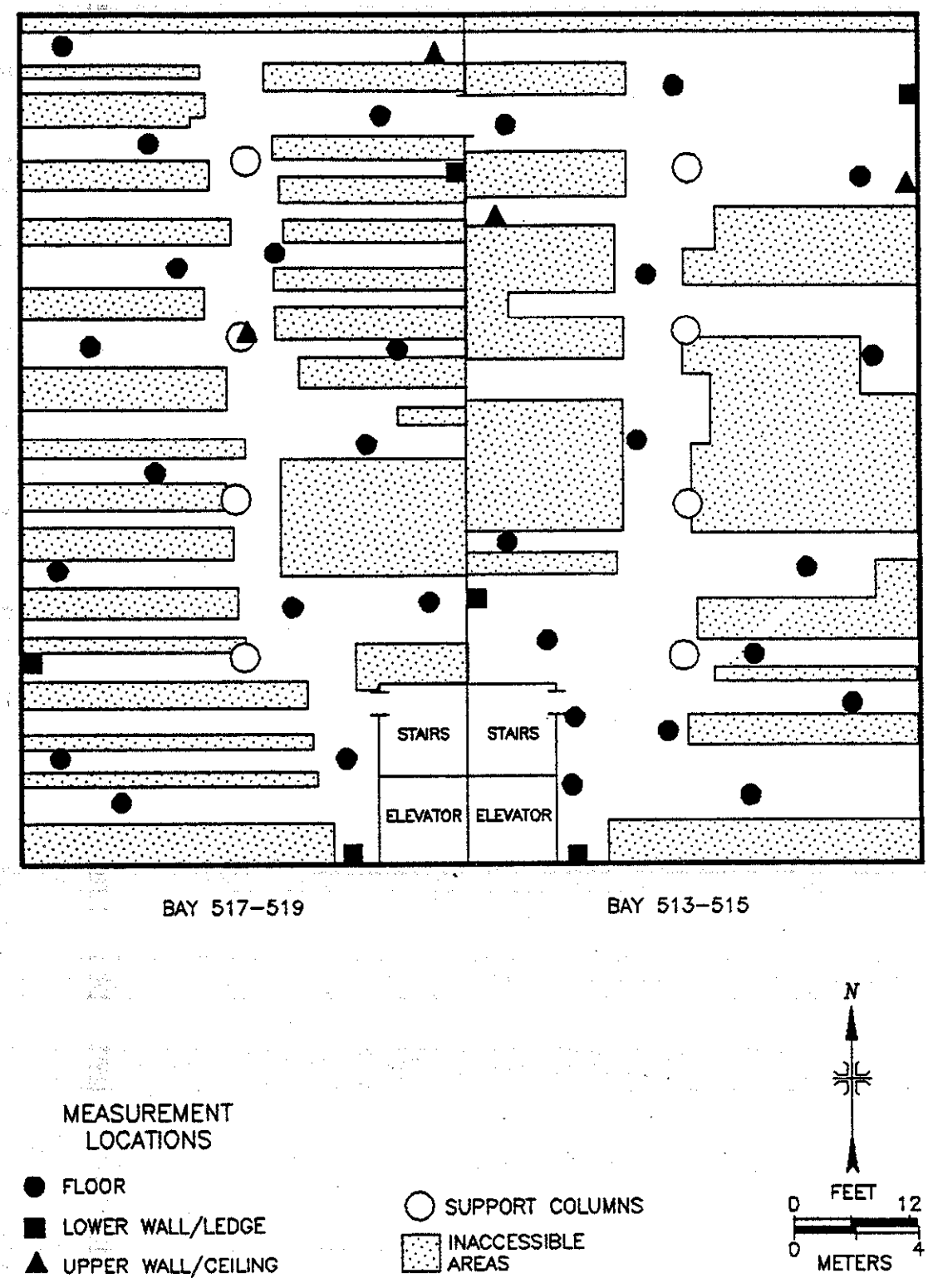

FIGURE 9: Sixth Level – Measurement Locations

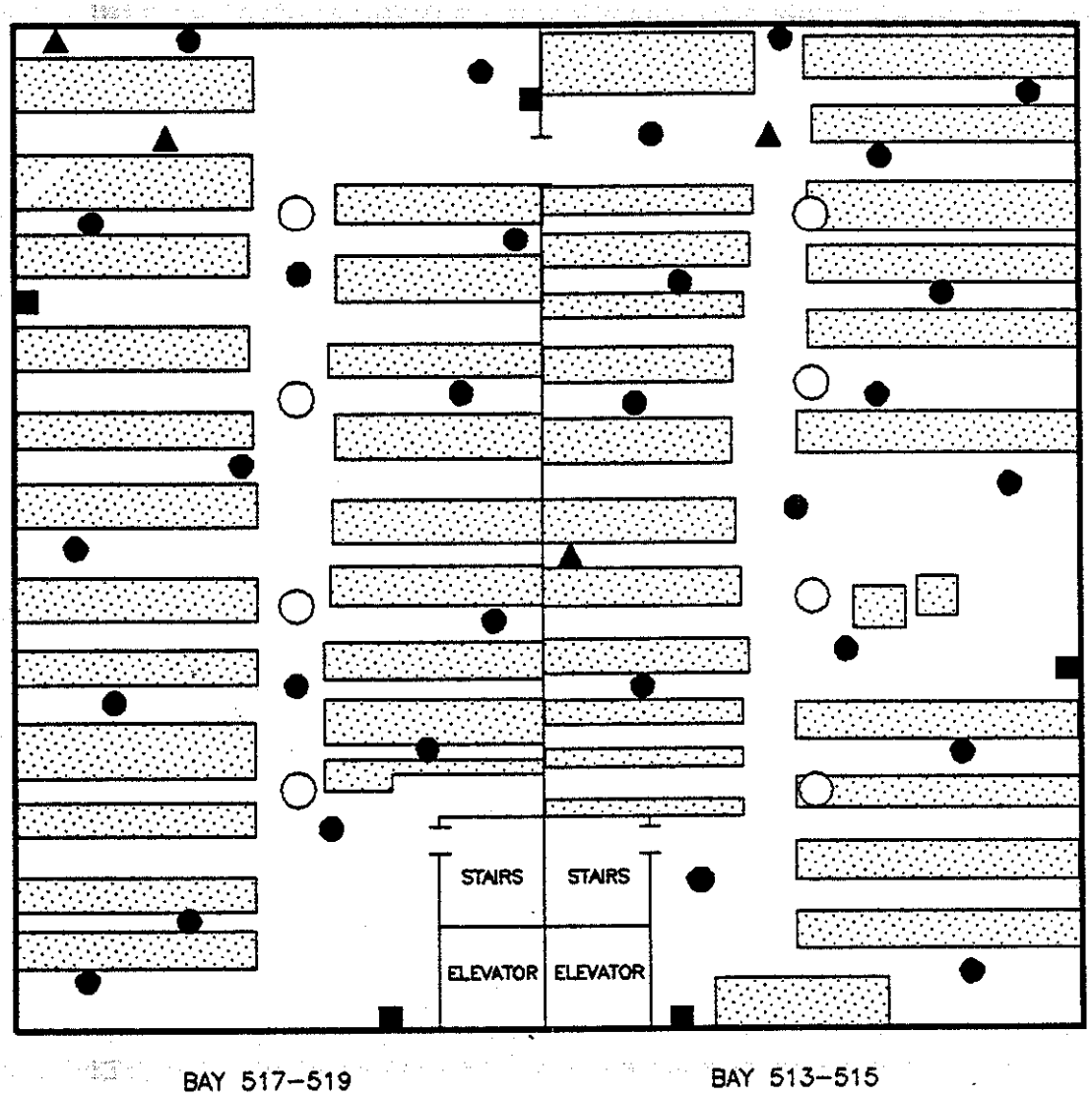

FIGURE 10: Seventh Level – Measurement Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BUILDING 513-519
BAKER AND WILLIAMS WAREHOUSES
NEW YORK, NEW YORK

Level	Figure #	Location	# of Measurements	Total Activity dpm/100 cm²		Removable Activity dpm/100 cm²	
				Alpha Range	Beta-Gamma Range	Alpha Range	Beta Range
Basement	3	Floor Lower Wall	19 2	<70 - 3,900 <70	<930-140,000 1,100	<6 - 72 <6	<13 - 84 <13
1st	4	Floor	16	<70 - 250	<930- 24,000	<6	<13
2nd	5	Floor	16	<70	<930- 2,000	<6 - 7	<13 - 13
3rd	6	Floor Lower Wall U. Walls/Ceiling	19 3 1	<70 - 9,100 91 - 150 <70 - 1,000	<930-710,000 6,500- 11,000 <930- 11,000	<6 - 340 <6 - 9 9 - 54	<13 - 320 <13 - 14 <13 - 30
4th	7	Floor Lower Wall U. Walls/Ceiling	32 5 3	<70 <70 <70	<960 <960- 2,200 <960- 1,100	<6 <6 <6	<13 <13 <13
5th	8	Floor Lower Wall U. Walls/Ceiling	32 5 3	<85 - 140 <85 - 120 <85	<960- 9,200 <960- 7,000 <960	<6 <6 <6	<13 <13 <13
6th	9	Floor Lower Wall U. Walls/Ceiling	30 6 4	<85 <85 <85	<960 <960 <960	<6 <6 <6	<13 <13 <13
7th	10	Floor Lower Wall U. Walls/Ceiling	30 6 4	<85 <85 <85	<960 <960 <960	<6 <6 <6	<13 <13 <13

REFERENCES

1. Bechtel National, Inc.; Formerly Utilized Sites Remedial Action Program, "Implementation Plan For Radiological Surveys Protocols," July 1988.

2. Oak Ridge Associated Universities, Radiological Survey of the Baker and Williams Warehouses, New York, New York, June 1990.

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

The display or description of a specific product is not to be construed as an endorsement of that product or its manufacturer by the authors or their employer.

A. Direct Radiation Measurements

Eberline "RASCAL"
Portable Scaler-Ratemeter
Model PRS-1
(Eberline, Santa Fe, NM)

Eberline PRM-6
Portable Ratemeter
(Eberline, Santa Fe, NM)

Eberline Alpha Scintillation Detector
Model AC-3-7
(Eberline, Santa Fe, NM)

Eberline Beta-Gamma "Pancake" Detector
Model HP-260
(Eberline, Santa Fe, NM)

Ludlum Scaler-Ratemeter
Model 2220
(Ludlum Measurements, Sweetwater, TX)

Ludlum Scaler-Ratemeter
Model 2221
(Ludlum Measurements, Sweetwater, TX)

Ludlum Gas Proportional Floor Monitor
Model 239-1
(Ludlum Measurements, Sweetwater, TX)

Victoreen NaI Scintillation Detector
Model 489-55
(Victoreen, Cleveland, OH)

B. **Laboratory Analyses**

Low Background Gas Proportional Counter
Model BL-5110
(Tennelec, Oak Ridge, TN)

High-Purity Germanium Detector
Model GMX-23195-S, 23% efficiency
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead Shield, G-16
(Gamma Products, Palos Hills, IL)

Multichannel Analyzer
ND-66/MicroVax II
(Digital Equipment Corp., Maynard, MA)

APPENDIX B

MEASUREMENT AND ANALYTICAL PROCEDURES

APPENDIX B

MEASUREMENT AND ANALYTICAL PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. Scans of large surface areas on the floor of the facility were accomplished by use of a gas proportional floor monitor. The detector was slowly moved in a systematic pattern to cover 100% of the accessible floor area. Other surface were scanned using smaller, hand-held detectors. Combinations of detectors and instruments used for the scans were:

Alpha-plus-Beta	-	Gas Proportional Detector (550 cm^2) Floor Monitor with Scaler/Ratemeter.
Alpha	-	ZnS Detector (59 cm^2) with Scaler/Ratemeter.
Beta-Gamma	-	Pancake GM Detector (15 cm^2, 1.4 mg/cm^2 window) with Scaler/Ratemeter.
Gamma	-	NaI Scintillation Detector (3.2 cm x 3.8 cm crystal) with Ratemeter.

Surface Activity Measurements

Measurements of total alpha surface activity were performed using portable scaler/ratemeters with ZnS alpha scintillation detectors. Measurements of total beta-gamma surface activity were performed using portable scaler/ratemeters with thin-window "pancake" GM detectors. Count rates (cpm) were converted to disintegration rates (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. Effective window areas were 59 cm^2 for the ZnS detector and 15 cm^2 for the GM detector. The background count rate for the ZnS detector was 1 cpm and the average background count rate for the GM detectors was 52 cpm.

Efficiency factors varied with each individual detector used. The efficiency factors for the ZnS detectors ranged from 0.15 to 0.19, and for the GM detectors the efficiency factor was 0.26.

Removable Measurements

Smears for determination of removable activity were performed using numbered filter paper disks, 47 mm in diameter; smears were sealed in labeled envelopes with the locations and other pertinent information recorded. The smears were returned to laboratories in Oak Ridge and counted on a low-background gas-proportional counter for gross alpha and gross beta activity.

Gamma Spectrometry

The sample was placed in an appropriate container, chosen to reproduce the calibrated counting geometry. The net weight was determined and the sample counted using a high purity germanium detector coupled to a Nuclear Data Model ND-66/Micro VaxII pulse height analyzer system. Background and Compton striping, peak search, peak identification, and concentration

calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks used for determination of radionuclides of concern were:

U-238	0.093 MeV from Th-234*
U-235	0.143 MeV

The spectrum was reviewed for other identifiable photopeaks.

*Secular equilibrium assumed.

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in this report represent the 95% confidence levels for that data. These uncertainties were calculated, based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedure. Because of variations in background levels, sample volumes or weights, measurement efficiencies, and Compton contributions from naturally occurring radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties of $\pm$ 6 to 10%, associated with laboratory procedures, have not been propagated into the data presented in this report.

Calibration and Quality Assurance

The Environmental Survey and Site Assessment Program conducted the survey and analytical activities in accordance with field survey and laboratory procedures which are documented in manuals developed specifically for the Oak Ridge Associated Universities. The specific manuals and procedures applicable to this survey were the "Quality Assurance Manual," February 1990, Revision 3; "Survey Procedures Manual," February 1991, Revision 6; and the "Laboratory Procedures Manual," April 1991, Revision 6.

With the exception of the measurements conducted with portable gamma scintillation survey meters, instruments were calibrated with NIST-traceable standards. The portable gamma scintillation survey meters were cross calibrated against a pressurized ionization chamber which was calibrated with NIST-traceable standards.

Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA and EML Quality Assurance Programs.

APPENDIX C

U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL AT FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL AT FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

(Revision 2, March 1987)

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive material and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).* The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Department of Energy 1986) and subsequent guidance. More detailed information on applications of the guidelines presented herein, including procedures for deriving site-specific guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in "A Manual for Implementing Residual Radioactive Material Guidelines" (U.S. Department of Energy 1987), referred to herein as the "supplement".

"Residual radioactive material" is used in these guidelines to describe radioactive material derived from operations or sites over which DOE has authority. Guidelines or guidance to limit the levels of radioactive material and to protect the public and the environment are

*A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

provided for (1) residual concentrations of radionuclides in soil,* (2) concentrations of airborne radon decay products, (3) external gamma radiation levels, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). The basic dose limits are used for deriving guidelines for residual concentrations of radionuclides in soil. Guidelines for residual concentrations of thorium and radium in soil, concentrations of airborne radon decay products, allowable indoor external gamma radiation levels, and residual surface contamination concentrations are based on existing radiological protection standards (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and DOE Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are used only when the guidelines provided in the existing standards cited above are shown to be inappropriate.

A "guideline" for residual radioactive material is a level of radioactive or radioactive material that is acceptable if use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement. The basis for the guidelines is generally a presumed worst-case plausible-use scenario for the site.

An "authorized limit" is a level of residual radioactive material or radioactivity that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use. The authorized limits for a site will include (1) limits for each

*"Soil" is defined herein as unconsolidated earth material, including rubble and debris that may be present in earth material.

radionuclide or group of radionuclides, as appropriate, associated with residual radioactive material in soil or in surface contamination of structures and equipment, (2) limits for each radionuclide or group of radionuclides, as appropriate, in air or water, and, (3) where appropriate, a limit on external gamma radiation resulting from the residual material. Under normal circumstances, expected to occur at most sites, authorized limits for residual radioactive material or radioactivity are set equal to guideline values. Exceptional conditions for which authorized limits might differ from guideline values are specified in Sections D and F of this document. A site may be released for unrestricted use only if site conditions do not exceed the authorized limits or approved supplemental limits, as defined in Section F.1, at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if site conditions exceed the approved limits, or if there is potential to exceed the basic dose limit if use of the site is not restricted (Section F.2). The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below authorized limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as reasonably achievable. Procedures for implementing ALARA policy are discussed in the supplement. ALARA policies, procedures, and actions shall be documented and filed as a permanent record upon completion of remedial action at a site.

B. BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr. The internal committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated by dosimetry models described in ICRP Publication 30 (ICRP 1978), plus the dose from penetrating radiation sources external to the

body, shall be used for determining the dose. This dose shall be described as the "effective dose equivalent." Every effort shall be made to ensure that actual doses to the public are as far below the basic dose limit as is reasonably achievable.

Under unusual circumstances, it will be permissible to allow potential doses to exceed 100 mrem/yr where such exposures are based upon scenarios that do not persist for long periods and where the annual lifetime exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/yr. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbably, one-time scenario that might occur following remedial action. These levels should represent doses that are as low as reasonably achievable for the site. Further, no annual exposure should exceed 500 mrem.

C. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

C.1 Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 m^2. Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using site-specific data where available. Procedures for these derivations are given in the supplement.

If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230, and Th-232 are:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface

- 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the appropriate guideline is applied as a limit to the radionuclide with the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit or 2) the sum of the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR Part 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.* In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive material is not the cause.

C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 μR/h and shall comply with the basic dose limit when an appropriate-use scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic dose limit, considering an appropriate-use scenario for the area.

C.4 Surface Contamination

The generic surface contamination guidelines provided in Table 1 are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory Commission (NRC 1982)* and will be applied to a manner that provides a level of protection consistent with the Commission's guidance. These limits apply to both interior and exterior surfaces. They are not directly intended for use on structures to be demolished or buried, but should be applied to equipment or building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

C.5 Residual Radionuclides in Air and Water

Residual concentrations of radionuclides in air and water shall be controlled to levels required by DOE Environmental Protection Guidance and Orders, specifically DOE Order 5480.1A and subsequent guidance. Other Federal and/or state standards shall apply when they are determined to be appropriate.

*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

Radionuclides[b]	Allowable Residual Surface Contaminants (dpm/100 cm^2)[a] Average[c,d]	Maximum[d,e]	Removable[e,f]
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000β-γ	15,000β-γ	1,000β-γ

[a]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instruction.

[b]Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[c]Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[e]The maximum contamination level applies to an area of not more than 100 cm^2.

[f]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

Authorized limits shall be established to (1) ensure that, as a minimum, the basic dose limits specified in Section B will not be exceeded under the worst-case plausible-use scenario consistent with the procedures and guidance provided or (2) be consistent with applicable generic guidelines, where such guidelines are provided. The authorized limits for each site and its vicinity properties shall be set equal to the generic or derived guidelines except where it can be clearly established on the basis of site-specific data -- including health, safety, and socioeconomic considerations -- that the guidelines are not appropriate for use at the specific site. Consideration should also be given to ensure that the limits comply with or provide a level of protection equivalent to the appropriate limits and guidelines (i.e., state or other Federal). Documentation supporting such a decision should be similar to that required for supplemental limits and exceptions (Section F), but should be generally more detailed because the documentation covers the entire site.

Remedial action shall not be considered complete unless the residual radioactive material levels comply with the authorized limits. The only exception to this requirement will be for those special situations where the supplemental limits or exceptions are applicable and approved as specified in Section F. However, the use of supplemental limits and exceptions should be considered only if it is clearly demonstrated that it is not reasonable to decontaminate the area to the authorized limit or guideline value. The authorized limits are developed through the project offices in the field and are approved by the headquarters program office.

E. CONTROL OF RESIDUAL RADIOACTIVE MATERIAL AT FUSRAP AND REMOTE SFMP SITES

Residual radioactive material above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A and

*These guidelines are functionally equivalent to Section 4 -- Decontamination for Release for Unrestricted Use -- of NRC Regulatory Guide 1.86 (U.S. Atomic Energy Commission 1974), but they are applicable to non-reactor facilities.

subsequent guidance or superseding Orders require compliance with applicable Federal and state environmental protection standards.

The operational and control requirements specified in the following DOE Orders shall apply to interim storage, interim management, and long-term management.

a. 5000.3, Unusual Occurrence Reporting System

b. 5440.1C, Implementation of the National Environmental Policy Act

c. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations, as revised by DOE 5480.1 change orders and the 5 August 1985 memorandum from Vaughan to Distribution

d. 5480.2, Hazardous and Radioactive Mixed Waste Management

e. 5480.4, Environmental Protection, Safety, and Health Protection Standards

f. 5482.1A, Environmental, Safety, and Health Appraisal Program

g. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities

h. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

i. 5820.2, Radioactive Waste Management

E.1 Interim Storage

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.

b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed (1) 100 Pci/L at any given point, (2) an annual average concentration of 30 Pci/L over the facility site, and (3) an annual average concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-I).

c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive material shall not exceed existing Federal or state standards.

d. Access to a site shall be controlled and misuse of on-site material contaminated by residual radioactive material shall be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, as effective life of at least 25 years. The Federal government shall have title to the property or shall have a long-term lease for exclusive use.

E.2 Interim Management

a. A site may be release under interim management when the residual radioactive material exceeds guideline values if the residual radioactive material in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.

b. The administrative controls as approved by DOE, shall include but not be limited to periodic monitoring as appropriate, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate.

c. The owner of the site or appropriate Federal, state, or local authorities shall be responsible for enforcing the administrative controls.

E.3 Long-Term Management

Uranium, Thorium, and Their Decay Products

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.

b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere form the wastes shall not (1) exceed an annual average release rate of 20 $pCi/m^2/s$ and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.

c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b. of this section (E.3) to be exceeded and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a. of this section (E.3).

d. Groundwater shall be protected in accordance with appropriate Departmental Orders and Federal and state standards, as applicable to FUSRAP and remote SFMP sites.

e. Access to a site should be controlled and misuse of on-site material contaminated by residual radioactivity should be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The Federal government shall have title to the property.

Other Radionuclides

f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

F. SUPPLEMENTAL LIMITS AND EXCEPTIONS

If special site-specific circumstances indicate that the guidelines or authorized limits established for a given site are not appropriate for a portion of that site or for a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field office must justify that the subject guidelines or authorized limits are not appropriate and that the alternative action will provide adequate protection, giving due consideration to health and safety, the environment, and costs. The filed office shall obtain approval for specific supplemental limits or exceptions from headquarters as specified in Section D of these guidelines and shall provide to headquarters those materials required for the justification as specified in this section (F) and in the FUSRAP and SFMP protocols and subsequent guidance documents., The field office shall also be responsible for coordination with the state or local government of the limits or exceptions and associated restrictions as appropriate. In the case of exceptions, the field office shall also work with the state and/or local governments to ensure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

F.1 Supplemental Limits

The supplemental limits must achieve the basic dose limits set forth in this guideline document for both current and potential unrestricted uses of a site and/or vicinity property. Supplemental limits may be applied to a vicinity property or a portion of a site if, in the basis of a site-specific analysis, it is determined that (1) certain aspects of the vicinity property or portion of the site were not considered in the development of the established authorized limits and associated guidelines for that vicinity property or site and, (2) as a result of these unique characteristics, the established limits or guidelines wither do not provide adequate protection or are unnecessarily restrictive and costly.

F.2 Exceptions

Exceptions to the authorized limits defined for unrestricted use of a site or vicinity property may be applied to a vicinity property or a portion of a site when it is established that the authorized limits cannot be achieved and restrictions on use of the vicinity property or portion of the site are necessary to provide adequate protection of the public and the environment. The field office must clearly demonstrate that the exception is necessary and that the restrictions will provide the necessary degree of protection and will comply with the requirements for control of residual radioactive material as set forth in Section E of these guidelines.

F.3 Justification for Supplemental Limits and Exceptions

Supplemental limits and exceptions must be justified by the field office on a case-by-case basis using site-specific data. Every effort should be made to minimize use of the supplemental limits and exceptions. Examples of specific situations that warrant use of the supplemental standards and exceptions are:

a. Where remedial action would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.

b. Where remedial action -- even after all reasonable mitigative measures have been taken -- would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

c. Where it is clear that the scenarios or assumptions used to establish the authorized limits do not, under plausible current or future conditions, apply to the property or portion of the site identified and where more appropriate scenarios or assumptions indicate that other limits are applicable or necessary for protection of the public and the environment.

d. Where the cost of remedial action for contaminated soil is unreasonably high relative t long-term benefits and where the residual radioactive material does not pose a clear present or future risk after taking necessary control measures. The likelihood the buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial action will generally not be necessary where only minor quantities of residual radioactive material are involved or where residual radioactive material occurs in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples include residual radioactive material under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. A site-specific analysis must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the level of residual radioactive material must be included in the appropriate state and local records.

e. Where there is no feasible remedial action.

G. SOURCES

Limit or Guideline	Source
Basic Dose Limits	
Dosimetry model and dose limits	International Commission on Radiological Protection (1977, 1978)
Generic Guidelines for Residual Radioactivity	
Residual concentrations of radium and thorium in soil	40 CFR Part 192
Airborne radon decay products	40 CFR Part 192
External gamma radiation	40 CFR Part 192
Surface contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
Control of Radioactive Wastes and Residues	
Interim storage	DOE Order 5480.1A and subsequent guidance
Long-term management	DOE Order 5480.1A and subsequent guidance; 40 CFR Part 192; DOE Order 5820.2

H. REFERENCES

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APPLICATION OF HOT SPOT GUIDELINE

1. The method for determining Hot Spot Limits, which is based on the 100 mrem/year Dose Limit, as described in the FUSRAP procedures manual, shall still be applicable for determining allowable concentrations of radionuclides under inhomogeneous soil contamination conditions. However, the following approach, more appropriate for field applications, may be used in place of the Dose Limit method and is recommended for general applications.

2. For the alternative approach, the basic Hot Spot Limits will be calculated for each specific site by (See attached figure):

   $Shg - Sg + (100\ m^2/A)^{1/2}$

   where, Shg = the Hot Spot Limit (pCi/gram)
   Sg = the Authorized Limit for a specific site (pCi/gram)
   A = the area of the hot spot in square meters
   $(100/A)^{1/2}$ is the hot spot multiplication factor.

3. The limits shall be applied in the field over ranges of area with the factors being constant over a given area. The ranges and factors to be used are:

Range	Factor (Multiple of Authorized Limit)
$< 1\ m^2$	10*
$1 - < 3\ m^2$	6
$3 - < 10\ m^2$	3
$10 - 25\ m^2$	2

   *Areas less than one square meter are to be averaged over the one square meter and that average shall not exceed ten times the Authorized Limit.

4. The average Authorized Limit is considered adequate to protect the public for areas larger than 25 square meters; hence, no special Hot Spot Limits are required for areas larger than 25 square meters.

5. Averaging of hot spots less than or equal to 25 square meters shall be done only over the local hot spot area.

6. Every reasonable effort shall be made to identify and remove any source which has a concentration of a radionuclide exceeding 30 times the Authorized Limit irrespective of area.